

**Original Article**  
**Orthopaedics**

**SOME OBSERVATIONS ON  
THE MANAGEMENT OF  
DISPLACED UNSTABLE  
INTRA ARTICULAR  
FRACTURES OF THE  
DISTAL END OF RADIUS  
BY OPEN REDUCTION  
AND INTERNAL FIXATION**

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**Abstract**

**Background:** Distal radius fracture crush the mechanical foundation of man's most elegant tool the Hand .Fractures of the distal end of radius are amongst the most common fractures encountered by orthopedic surgeon and at times most challenging. The aim of this study was to assess the functional results of treatment of displaced, unstable, intra articular fractures of distal end of radius {DER} by open reduction and internal fixation {ORIF} and to develop a more comprehensive treatment protocol in all displaced, unstable, intra articular fractures of distal end of radius.

**Methods:** This is a prospective study conducted on 25 patients of either sex in the age group of 20-50 years with displaced, unstable, intra articular fractures of distal end of radius managed by ORIF. Patients were followed up clinically and radiologically for a minimum period of 24 months.

**Results:** There were 80% good to excellent results, 12% fair and 8% poor results.

**Conclusion:** Our study support the new literature available in that open reduction and internal fixation is a very pertinent and satisfactory method in the treatment of these difficult and challenging fractures of displaced, unstable, intra articular fractures of distal end of radius in age group of 20-50 years.

**Keywords:** *Unstable intra articular fracture distal end radius ORIF*

## Introduction

Distal radius fracture crush the mechanical foundation of man's most elegant tool the Hand. No other fracture has a greater potential to devastate hand function and no metaphysis of bone is embraced by more precious soft tissue.<sup>[1]</sup> Fractures of the distal end of radius are amongst the most common fractures encountered by orthopedic surgeon and at times most challenging.<sup>[2]</sup>

Historically the accurate description of these fractures is first ascribed to Petit, Pouteau 1780 and Colle's 1804. Colle's article named "On the fracture of the carpal extremity of the radius", is considered a mile stone in the history of the radius fractures, wherein he gave a clear description of what is today commonly known as the Colle's fracture.

With time further facts and description of distal radius fractures was credited to Barton (1838), Dupuytren (1847) and Smith (1854). Today it is more important to determine the exact nature and anatomy of the fracture and describe the pathology involved, rather than link the diagnosis and treatment to a single name.<sup>[3,4,5]</sup>

As description of the fracture has evolved as has the variety of treatment modalities. Closed reduction and cast immobilization is one of the most easy method available but loss of reduction, restricted range of motion, muscle weakness and long term functional compromise complicates the results.<sup>[6]</sup>

Percutaneous pinning utilizes to hold large fragments, but these are of little use in small fragments. Pin tract infection and pin loosening complicate the follow up of patients in this treatment modality.<sup>[7,8]</sup>

External fixation (Ligamentotaxis) is a definite advance towards the attainment of joint congruity in intra

articular fractures.<sup>[9,10,11]</sup> However creation of extensor tightness, pin tract infection and inability to lift small fragments devoid of soft tissue attachment still leaves scope for more meticulous modality.<sup>[12,13]</sup>

Recent research has shown that, while restoration of the radial length and reduction of dorsal tilt of the articular surface of the distal part of the radius forms the basic goal of treatment for most fractures of the distal end of radius from functional point of view, but the critical factor to avoid development of post traumatic arthritis is the restoration of the articular surface congruity.<sup>[14,15,16,17]</sup>



The inherent instability of comminuted fractures of the distal end of the radius is supported by the fact that even when articular congruity is achieved by longitudinal traction, the fragments tend to settle into a position of incongruence during the period of immobilization. In an effort to improve clinical outcome after the intraarticular fractures, it is recommended that distal radial fracture fragments be reduced operatively when articular incongruencies exceed to 2 mm.<sup>[4,5,18]</sup>

Ellis (1965) was the first person to describe open reduction and internal fixation for fractures of the distal end of radius using a T-shaped buttress plate, for volar Barton and Smith fractures. Subsequently Knirk and Jupiter (1986), Fernandez and Geissler (1991), Cooney (1992), Rikli and Reagazoni (1996) and Carter, Frederick and Laster (1998) have shown in their studies that the restoration of articular congruency is much more important than restoration of volar angulation and radial length

for this group of injuries.<sup>[19,20,21,22,23,]</sup> Advancement in the design and biomechanics of both dorsal and volar plates have taken place to allow a more snug fit on both anatomic surfaces to better withstand the immediate post operation demands, including axial loading, bending and distal fragment rotation.<sup>[24,25,26,27,28,29,30,31]</sup>

With the evaluation of a greater understanding of the intra articular fracture patterns, the need for a more meticulous and perfectionist attitude towards distal end radius fracture is being felt. This technique is one step in the direction of the fulfillment of this need.

## Materials And Methods

This study titled "Some observations on the management of displaced unstable intra articular fractures of the distal end of radius by open reduction and internal fixation" was a prospective study conducted on 25 patients of either sex in the age group of 20-50 years with displaced, unstable, intra articular, fractures of distal end of radius admitted in MMABM Hospital Aanantnag and SKIMS Medical collage Bemina from April 2013 to march 2017.

The inclusion criteria were in consonance with AO classification of the fractures of distal end of radius. All unstable fractures including;

1. B1 (Chauffeurs's fracture).
2. B2 (Dorsal Barton).
3. B3 (Volar Barton) .
4. C1 and C2 (Complete articular fracture)
5. C3 (Multi fragmentary articular fracture).

And all fractures with metaphyseal instability criteria including:

- a. Fractures with volar obliquity displacement more than 2 mm.
- b. Die punch fractures.

- c. More than 20° dorsal angulation.
- d. Dorsal comminution more than 1/3<sup>rd</sup> of AP diameter of radial shaft.
- e. Any fracture that loses reduction .
- f. Radial shortening of more than 5mm.
- g. Associated ulnar fracture.

Were included in this study. Presence of more than two criteria were used as an indication for open reduction and internal fixation.

**Exclusion criteria:** All such patients with fracture distal end of radius were excluded from the study who had :

1. Age less than 20 years and more than 50 years.
2. Poly trauma.
3. Stable fractures.
4. Compound fractures > grade 1 (Gustilo Anderson).
5. Associated carpal injuries.

**Pre- operative assessment**

All these patients were clinically assessed with particular stress on motor and sensory function of median,ulnar and radial nerves. Subsequently, standard X-ray projections (AP, Lateral and Oblique views) of the wrist with forearm of both normal and fractured limbs, were taken in every patient. Routine hemogram, ECG, Chest X ray and other relevant investigations were done in all cases.

**Operative Management**

The operative procedure was done after taking informed consent of the patient, under general anesthesia / regional block (Axillary block) and under tourniquet control. The part was shaved thoroughly scrubbed with betadine lotion and appropriately draped. The limb was placed on aside

trolley with fore arm pronated or supinated depending on the approach. The tourniquet time was not allowed to exceed 60-90 minutes and then reinflated.

If there was metaphyseal instability due to comminution, severely swollen wrist or soft tissue damage, we use a bridging external fixator to maintain length and obtain immobilization.

Dorsal, volar or combined approaches were used depending on the fracture configuration and angulation.

**Indications for Dorsal approach**

1. Comminuted, dorsally displaced intra articular fractures of distal end of radius (AO: C2-C3).
2. Die punch fractures.
3. Dorsal Barton fractures.

**Indications for Volar approach**

1. Volar Barton fracture .
2. Comminuted intra articular fracture with volar obliquity / displacement more than 2mm.
3. If longitudinal traction applied and carpus translated volarly.

**Indications for combined approach**

1. Severely comminuted intra articular fractures with impaction of fragments or displacement in both directions,where reduction was not possible through single approach.

**Approaches**



**Dorsal Approach**

A dorsal longitudinal incision was

made between 3<sup>rd</sup> and 4<sup>th</sup> extensor compartments 7.5cm long beginning 0.5 cm distal to Lister’s tubercle and extending proximally. The fourth compartment was elevated sub periosteally leaving the inferior surface of the compartment intact which minimizes contact irritation of the extensor tendon over a dorsally placed implant. The extensor pollicis longus tendon was mobilized and was left above the retinaculum at the time of wound closure to avoid tendon injury either by subsequent ischemia or by direct contact with an implant, also this tendon does not bow string owing to its oblique course across the wrist. The joint was opened along the joint line either manually or with the help of external fixator (ligamentotaxis). The fragments were manipulated into exact position with small elevators. Ulnar aspect of the distal radius was reduced first and rest of radius was built around it. Once satisfactory reduction was achieved a pre contoured T -plate was fixed with 3.5 mm screws. Sometimes the Lister’s tubercle was osteotomized to snug fit the dorsally placed T plate. The size of T plate used depend upon the distance of comminution of fracture from the articular surface. In some cases we used K wires , lag screws and small screws to hold the comminuted unstable fragments.

A 2<sup>nd</sup> Dorsal approach lies between 4<sup>th</sup> and 5<sup>th</sup> compartments. This approach was preferred when limited open reduction of fracture affecting the lunate facet was required (Die punch). Also distal radio ulnar joint (DRUJ) was visualized through this approach.

**Volar Approach**



For fractures affecting the volar rim of the distal radius such as volar Barton, surgical approach was that of terminal part of the classical Henry's approach. An incision was made between the flexor carpi radialis longus and radial artery, this interval was developed revealing flexor pollicis longus muscle belly at more proximal extent of the wound and pronator quadrates more distally. The radial artery was carefully retracted in the radial direction, while the tendons of the flexor carpi radialis and flexor pollicis longus were retracted ulnar wards. The pronator quadrates was divided at its most radial aspect, leaving a small cuff for later attachment. Any elevation of muscle belly of the flexor pollicis longus was performed at its radial aspect, as it receives interosseous nerve on its ulnar side. After the division of pronator quadrates, fracture site was visualized and reduction maneuver was accomplished under direct vision and fixation achieved by Buttress T plate, K wires or lag screws was done.

If the volar fragment had a sagittal split, the fracture line was reduced and held with fixation of screws in the distal holes of plate eccentrically at the outer edges of the hole. This creates a compression effect to the sagittal fracture line with tightening of the screws. Volar rim fractures or more extensive comminution having independent fragment instability required separate initial fixation with mini screws, K wires or mini plates, before applying the Ellis plate. When the fracture was associated with symptoms of acute median nerve compression, an S shaped incision was given beginning from radial side towards the ulnar head and then across the palm. The flexor tendons were mobilized radial ward and ulnar

nerve artery in ulnar direction. In this approach the pronator quadrates was partially divided at its most distal aspect overlying the distal radio ulnar joint to provide exposure to this area. We did not disturb the volar radio ulnar ligament and volar aspect of triangular fibro cartilage complex. The most distal part of this incision represents the standard incision for carpal tunnel release. The transverse retinacula ligament was repaired by Z lengthening of this ligament.

### **Intra operative assessment**

Satisfactory reduction was said to be achieved when:

1. Ulnar inclination more than 10°.
2. Palmer inclination more than 0°.
3. Ulnar variance 0 to – 2mm.
4. Less than 2mm loss of radial length.
5. Less than 2mm step of joint incongruity.
6. Stable distal radio ulnar joint.
7. Articular diastasis less than 2mm.

This was ensured under image intensifier.

### **Distal radio ulnar joint assessment**

If distal radio ulnar joint was stable in supination, we splinted the limb in long arm slab in supination for 3 weeks.

If it was stable in pronation, then K wire from ulnar head to distal end of radius in mid pronation were used.

If it was unstable through out:

- a). If ulnar styloid was fractured it was reduced in full supination, if not tension band wiring was done.
- b). If ulnar head was fractured, it was fixed with K wires.
- c). If ulnar neck was fractured,

it was also fractured with K wires.

Bone grafting was done to maintain stability and help in healing process, it was used in

- a). Die punch fractures.
- b). Excessive metaphyseal comminution.
- c). Depressed fragments with metaphyseal bone loss.

Bone grafts was taken as a cancellous or cortico cancellous strut grafts from ipsilateral iliac crest and applied at fracture site. Closure was applied over suction drain and tourniquet released.

### **Post operative care**

We applied posterior removable splint with wrist in neutral position for the first two post operative weeks. Again median, ulnar and radial nerve functions were tested during this period. After two weeks skin sutures were removed and a removable splint was applied for next two weeks. The patient was encouraged to use his or her hand for activities of daily living, but manual work or sports were forbidden for 6-8 weeks, at which time fracture consolidation is complete.

Also post operatively broad-spectrum antibiotics were infused and hydration and analgesia was taken care off. Patients were discharged on 4<sup>th</sup> day post operatively.

Physiotherapy was started on 1<sup>st</sup> post-operative day and constituted

Codman's six pack system i.e;

1. Maximal extension of all digits.
2. Thumb to each finger.
3. Grasp or fist exercises with all fingers flexing to palmer crease or as near as possible to it.
4. The claw exercises with metacarpophalangeal joints of all fingers kept extended but interphalangeal joints flexed.

5. The table top exercises.
6. Abduction and adduction of all digits with full use of elbow and shoulder.

At four weeks post operatively external fixator was removed, the K wires were removed 10 days later. If k wires were used alone to maintain stabilization, they were removed at the end of 3<sup>rd</sup> week.

Post-operative radiographs were taken at 2 weeks, 4 weeks, 6 weeks, 12 weeks and 24 weeks with follow up at corresponding time.

**Follow up**

Functional assessment was done at 24 weeks using modified Lidstorms radiographic grading and modified Gartland and Werley’s demerit point system score.

The objective evaluation was based on the following ranges of motion as being the minimum for normal function:

Extension 45°, palmer flexion 30°, radial deviation 15°, ulnar deviation 15°, pronation 50° and supination 50°.

**Results**

The age of the patients ranged from 20 – 50 years with average age of presentation 34.20 years, out of 25 patients 21 were males and four females, which shows that this type of injury is most common in young and more labors workers. In our study of 25 patients 13 (25%) cases were having dominant side involvement as compared to 12 (48%) cases of non-dominant side. Out of 25 cases 12 (48%) cases sustained the injury from fall from height, 12 (48%) from road traffic accident and one from direct blow.

**Table 1**

Mode of Injury	No. of patients	%age
Fall from height	12	48%
Road traffic accident	12	48%
Direct blow	1	4%

Out of 25 patients according to AO classification the percentage of fractures were given in table:

**Table 2**

Type	No. of patients	%age
B1	1	4%
B2	3	12%
B3	11	44%
C1	2	8%
C2	4	16%
C3	4	16%

It is clear from above table that type B3 (Volar Barton) fracture constitutes the major group in our study. However, injuries from all groups of AO classification (inclusion criteria) were represented.

The patients stayed in the hospital from a period of 1-10 days with an average of 6.55 days and we operate within 7 days in 23 (92%) cases and within 10 days in 2 (8%) cases. We approach the fracture through volar side in 15 (60%) cases, dorsal side in 6 (24%) cases and both volar and dorsal in 4 (16%) cases.

We used Ellis buttress plate and K wires mostly in 15 (60%) cases and sometimes we used lag screws and k wires to hold small fragments in comminuted intra articular fractures of distal end of radius as shown in table 3.

**Table 3**

Type	No. of patients	%age
Ellis plate	5	20%
Ellis plate +External fixator	2	8%

Ellis plate +k wire	10	40%
Ellis plate +K wire+ external fixator	4	16%
Ellis plate +K wire +lag screw	3	12%
K wire	1	4 %

Most of our patients have stable distal radio ulnar joint 17 (68%) and 8 (32%) had unstable distal radio ulnar joint intra operatively on table. This assessment was done after the fixation of the distal radius fracture. For these unstable DRUJ 4 (16%) were stable in pronation and we stabilized them with K wire in mid pronation from ulnar head to radius and in 3 (12%) DRUJ was unstable throughout and had fractured ulnar styloid for which we used tension band wiring to fix ulnar styloid and triangular fibro cartilaginous complex and 1 (4%) of cases had stable DRUJ in supination where we applied a long arm slab in supination.

Functional analysis of the patients in our study revealed that 16 (64%) of our patients reported no pain during follow up period while 7 (28%) reported occasional pain and 2 (8%) patients reported mild pain which restricted them in doing heavy work. 23 (92%) cases return to normal work and 2 (8%) cases ended up with slight limitation of activities. 18 (72%) of our patients achieved a mean range of motion which was >69% of that of normal side. 20 (80%) of our patients achieved grip strength of 80%- 100% of normal side.

Radiologically; 15 (60%) of our patients had no dorsal angulation, 7 (28%) had 1°-5° of dorsal angulation, 3 (12%) had 6°-10° of dorsal angulation. 17 (68%) of our patients have no loss of ulnar inclination, while as 5(20%)

patients had 1<sup>0</sup>-5<sup>0</sup> loss and 3 (12%) had 6<sup>0</sup>- 10<sup>0</sup> loss as compared to normal side. 18 (72%) of our patients had no radial shortening 6 (24%) had 1-2mm shortening and 1 (4%) had 2-4 mm radial shortening. 17 (68%) of our patients had zero ulnar variance ,5 (20%) of patients had 1mm positive ulnar variance and 3 (12%) of patients had negative – 2mm ulnar variance.

### Complications

From our study it is revealed that 4 (16%) patients develop pin tract infection by the application of external fixator which resolved within one week on antibiotics and thorough pin tract care. EPL attrition was found post operatively in one patient after 3 months of surgery which resolved of its own by restricting the patient's activities. Reflex sympathetic dystrophy was seen in 2 (8%) patients, both patients were non-compliant with physiotherapy regimen prescribed post operatively, both these patients had poor functional outcome.

Final outcome of the patients was done using modified Lidstorms radiographic grading, which shows 18 (72%) of our patients fall in grade I, 7 (28%) in grade II, and 0% in grade III. And functionally by using modified Gartland and Werley's demerit point system scoring according to which 20 (80%) of our patients were graded as good to excellent, 3 (12%) graded as fair, 2 (8%) graded as poor results.

### Discussion

Treatment of unstable, displaced, comminuted fractures of distal end of radius with conservative methods is disappointing, e.g., closed reduction and plaster of Paris cast results in loss of reduction and prolonged immobilization which compromise the functional outcome.<sup>[1,6,10,11,15]</sup>

Pins and plaster does not correct the functional anatomy as well as radiological anatomy accurately.<sup>[7]</sup> Although external fixators have been clearly shown to improve the anatomic and functional results of unstable distal radial fractures, however, they are expensive and inconvenient for the patients and require significant maintenance on the part of the surgeon and therapist.<sup>[10,11,12,13]</sup> The complication rate of external fixation treatment for distal radius fractures is well documented and consistent with similar devices spanning joints in other areas of Skelton where they have been abandoned because open reduction and internal fixation is possible.<sup>[14,15]</sup> Open reduction and internal fixation allow accurate reduction of articular surface as well as alignment of distal end of radius with respect to ulna and wrist and it facilitates early physiotherapy and rehabilitation.<sup>[4,31,32,33,34,35,36]</sup>

We have compared, in present study the functional results of 25 patients with unstable comminuted displaced intra articular fractures of distal radius with other studies like Lee et al (1992), Jupiter et al (1993), Hove et al (1997), Nienstedt et al (1999), and Cataleno (1997), and found comparable results in respect of age, sex and dominant side involvement as these fractures usually occurs in young laborers males with high energy trauma.<sup>[23,37,38,39]</sup> The most common fracture in our study was volar Barton where as in other studies its comminuted intra articular fracture. The time to operate, approach and implant used is similar to other studies. We had pre-operative complications like median nerve palsy in 25% cases as compared to other studies, which was resolved after carpal tunnel release at the time of surgery. Our study encountered the same complications like pin

tract infection, ulnar nerve palsy, EPL attrition and RSD as in other studies. Functional and radiological analysis show that our results were comparable with other studies in pain, range of motion, grip strength and maintenance of radiological angles and variance. Final outcome according to modified Gartland and Werley's demerit point system scoring, our results were comparable with the results of other studies as 80% good to excellent and 20% fair to poor.

The increased use of internal fixation for distal radius fractures may be slowing. Treatment type continues to differ widely across demographic groups, underscoring the need for standardization. In accordance with value-based care initiatives, treatment decisions should be made to combine patient needs with financial implications on the health system<sup>(39)</sup>.

The advantages of a volar exposure and plating include the following: (1) Dorsally displaced fractures are simpler to reduce because the volar cortex is usually disrupted by a simple transverse line; (2) anatomic reduction of the volar cortex facilitates restoration of radial length, radial inclination, and volar tilt; (3) the avoidance of dissection dorsally helps to preserve the vascular supply to the dorsal fragments; (4) because the implant is separated from the flexor tendons by the pronator quadratus, the incidence of flexor tendon complications is lessened<sup>(40,41)</sup>.

### Conclusion

Depending on the type of distal radius fracture, several modalities of fracture fixation have evolved including plaster of Paris, plaster and pins ,external fixator (bridging and non-bridging). However, several fracture patterns remain unresolved

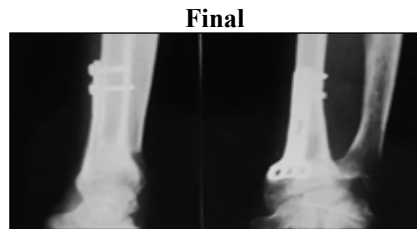
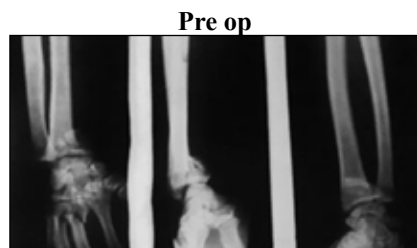
in spite of the several modalities available. These fractures include

1. B1 (Chauffer's fractures).
2. B2 (Dorsal Barton fracture).
3. B3 (Volar Barton fracture).
4. C1 and C2 (Complete articular fracture).
5. C3 (Multi fragmentary articular fracture).

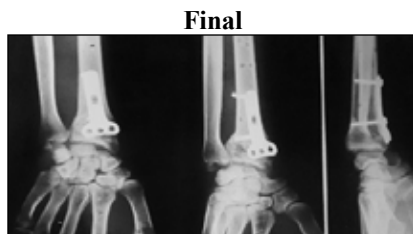
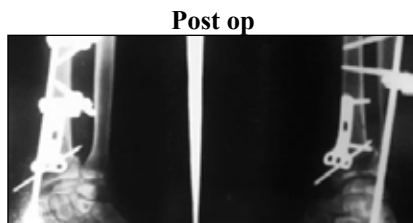
As per the AO classification.

Our study supports the new literature available in that open reduction and internal fixation is a very pertinent and satisfactory method in the treatment of these difficult and challenging fractures.

**Case I**



**Case II**



**Case III**



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